

# Analysis of the Logistics Research in India – White Paper

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## 1. Introduction

### General introduction

This year, the 60 years of Indo-German diplomatic relations were celebrated in a series of events called "Germany and India 2011-2012: Infinite Opportunities". In this context, leading German logistics institutes (Dortmund, Darmstadt, Münster, Erlangen-Nürnberg) carried out a research project entitled "Analysis of the logistics research in India – An empirical and bibliographical study for the description of the current state of the art in the field of logistics in India 2011/2012". As is the case with the above-mentioned celebration, this project was initiated and supported by the German Federal Ministry of Education and Research (BMBF). The project's main goal was to identify, analyze and describe the scientific and cooperative research in the field of logistics and supply chain management in India. The study provides a comprehensive overview of the current state of the art in the logistics research sector and helps identify opportunities for academic and industrial research cooperation.

An overarching purpose of this study was the identification of relevant logistics clusters in India and the exploration and initiation of new cooperations, as only these can provide the prerequisite for our countries to promote and build on bilateral exchange of knowledge – at both an international and intercultural level. A common platform for exchange of experience can thus facilitate an effective mutual transfer of knowledge between partners in India and Germany. In terms of specific goals we identify, analyze and describe the scientific and cooperative research in the field of logistics and supply chain management in India. Further, we identified current trends in Indian logistics research.

## Research questions

To achieve the aims, the following research questions were formulated:

- Which are the relevant institutions in India for logistics research and education?
- Which research topics are currently discussed in the field of logistics?
- What research aims at:
  - Solutions for the optimization of logistics nodes,
  - Integration of logistics centres,
  - Risk evaluation of logistics chains and
  - Improvement of infrastructure for commercial traffic?
- Where are the relevant logistics clusters in India and who belongs to them?
- Are there cooperations on regional, national or international level with other research institutions and / or with the logistics industry?
- Which trends can be observed in logistics research in India?

## Motivation for the study

Cooperation between India and Germany would be an advantage for both sides, as on the one hand, even though concepts successful in Germany still will need to be adapted to the Indian context, in the field of logistics, India can learn a lot from Germany. Similarly, India is a very interesting market opportunity for German service providers (e.g. educational export). Further, concerning research, certain topics and fields could be analyzed that are not relevant in Germany (e.g. issues in mega cities).

Against this background, it seemed useful to create an extensive base of information and to capture the current state of the art of Indian logistics research and cooperative projects. For the framework of a baseline study, the current state of logistics and commercial traffic needed to be analyzed. Following this, innovative approaches can be developed and adapted according to Indian conditions. For the identification of and cooperation with potential or relevant clusters, a common Indo-German platform should be established. Based on this platform, an intensive exchange of experience and bilateral transfer of knowledge could be initiated. In this context, the results can be used as a data source for further research approaches concerning (for example) mobility in mega cities. A further topic for future cooperation could be to transfer research approaches regarding supply chain risk management in to new common research activities.

## 2. Methodology and general results

### 2.1 Study methodology

With a bibliographical and online research the most relevant, current and important research topics along with the relevant institutions in the field of logistics in India were identified. First, the research in the field of logistics of Indian Institutes of Management and Technology (IIMs and IITs) was analyzed. The research was extended to internationally high-ranked journals and conference proceedings focused on logistics and supply chain management to gain a complete overview of the relevant research sites, authors and topics in the field of logistics in India. The goal of this research, carried out in early 2012 was to conduct a comprehensive search to identify the research interests and publications of Indian academics in the area of logistics and supply chain management.

Based on the results of this pre-study, further research institutions in India were identified. With a further extended online research additional data on the identified institutions was collected (e.g. number of researchers in this field and their research focus) and experts for interviews identified. Further, a structured interview questionnaire was developed and a study tour to India was organized to conduct telephone and personal interviews with the most prominent researchers. The personal interviews focused on the regions Chennai, Ahmedabad, Delhi and Bombay. The interviews were then transcribed and evaluated taking into account the research questions. Building on these results, the essential requirements for research were derived and transferred into an Indo-German research strategy, as discussed later in the document.

### 2.2 Institutions and experts identified through publication analysis

Based on the search procedure described above, 20 institutions were identified that are most actively involved in logistics research. These Top-20 institutions are depicted in the map in Figure 1. The radius of the dot signifies the number of publications found for each institution. The results clearly show that there is a certain gap between those institutions that have a considerable amount (i.e. more than 80) of logistics-related publications (IIT Delhi, IIT Kharagpur, IIT Madras, IIT Roorkee, IIT Bombay) and the others. Only three institutions (IIM Calcutta, IIM Lucknow, and IIM Ahmedabad) fall within the scope

of 40 to 80 publications. The other fourteen institutions are more or less far behind. Interestingly, the top 5 institutions are all IITs. This indicates that research in the area of logistics and SCM can mainly be found at the more technically-oriented institutions in India.

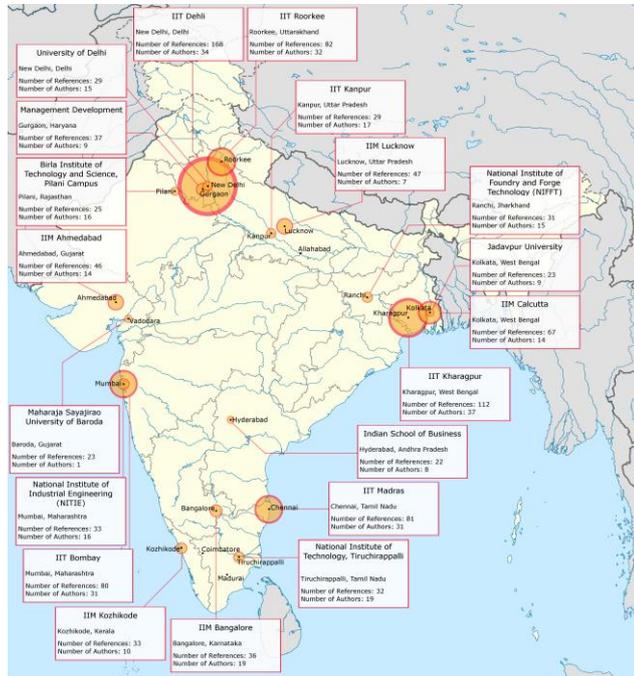


Figure 1: Leading Indian academic institutions

Table 1 shows the top Indian academics, in terms of logistics/SCM research output. The table is sorted by the number of publications.

Rank	Name	Institution	No.
1	Ravi Shankar	IIT Delhi	71
2	Manoj Kumar Tiwari	IIT Kharagpur	58
3	SG Deshmukh	IIT Delhi	48
4	Pradeep Kumar	IIT Roorkee	42
5	Samir K Srivastava	IIM Lucknow	39
6	Dinesh Kumar	IIT Roorkee	32
7	Vipul Jain	IIT Delhi	29
8	T.T. Narendran	IIT Madras	26
9	D.K. Banwet	IIT Delhi	24
10	S. P. Sarmah	IIT Kharagpur	24
11	Subhash Wadhwa	IIT Delhi	24
12	M.N. Qureshi	Maharaja Sayajirao Univ.	23
13	Arun Kanda	IIT Delhi	22
14	C.Rajendran	IIT Madras	21
15	Prem Vrat	ITM University	21
16	Chandra K. Jaggi	University of Delhi	18
17	J. Venkateswaran	IIT Bombay	17
18	N.Jawahar	Thiagarajar College of Eng.	14
19	A. Subash Babu	IIT Bombay	13
20	K. Chaudhuri	Jadavpur University	13

Table 1: Leading Indian academics and publications in logistics/SCM

Not surprisingly, the findings largely correspond to those concerning the most important institutions. The eleven researchers that are most productive with regard to the field of logistics and SCM are working at one of the IITs. When compared to the absolute numbers of researchers identified for each institution, it becomes clear that there typically are a small number of very influential researchers that accounts for a great share of the overall publications of an institution. Prof. Ravi Shankar and Prof. Deshmukh at the IIT Delhi are striking examples. The high amount of researchers at many of the institutions that only contributed to a small share of the overall publications, are most probably PhD students working at the institutions for a limited time only.

### 2.3 Logistics research map of India

In order to help select the on-site visits (for conducting the qualitative interviews) it was important to identify the most active geographical areas. Thus, the number of publications per city was analyzed. Figure 2 shows these top cities in terms of research output. The larger the radius of the point the greater the number of publications found in that area.

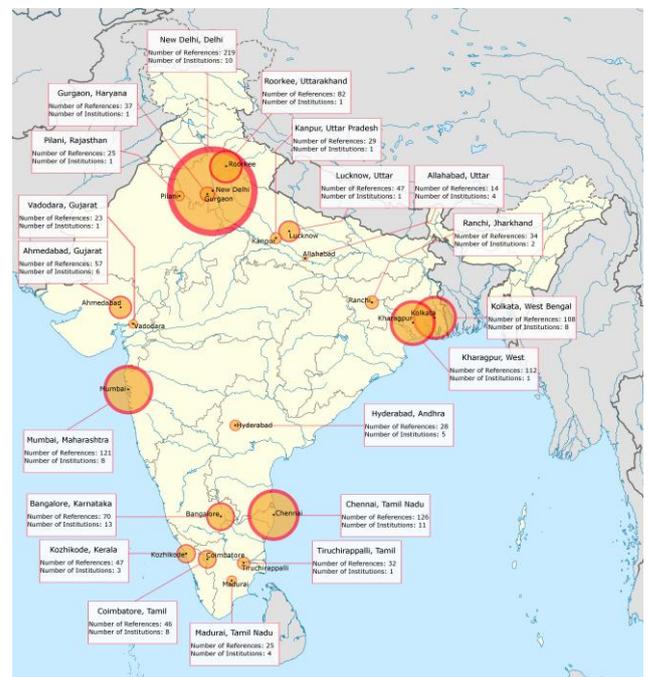


Figure 2: Top-20 cities in India

The cities of New Delhi, Kolkata, Chennai, Coimbatore, Bangalore and Mumbai each host more than eight institutions. Especially for Kolkata, Mumbai and Chennai this leads to an increase in importance in comparison to e.g. Kharagpur that only hosts one institution.

### 3. Focus and cooperation practices of logistics research in India

#### 3.1 Prevailing topics and institutions of logistics research in India

In this section, we provide an overview of the most active institutions and their main specializations in logistics research. There are experts in supply chain management, transport logistics and internal logistics as well as operations research. But most of the interviewed researchers are focused on supply chain management. In the field of transport logistics, researchers put their main focus on transportation systems and planning. Researchers at technical based institutions are rather specialized in operations research and optimizations.

Using the results from the literature review, we identified the institutions and researchers most active in the field of supply chain management. The second part of the study revealed that most of the researchers are in groups related to public systems and transportation. They are primarily located in the civil engineering departments and management departments. The most active institutions with a focus on logistics are IIT Delhi, IIT Kharagpur, IIT Madras, IIT Roorkee and IIT Bombay. The research in the area of logistics and SCM can mainly be found at the more technically-oriented institutions. Further research capacities in SCM and transport logistics are located in departments of management studies and civil engineering.

At almost every IIT, particularly IIT Bombay, there was evidence of active interest in SCM. Similarly, almost every IIM, particularly Ahmedabad, Calcutta and Kochi, had logistics-focused research specialists. There are several further institutions, which focus on logistics issues in research, namely:

- ITM University of Gurgaon
- Centre of Excellence in Urban Transport at the Center for Environmental Planning and Technology (CEPT University)
- MDI Gurgaon
- Institute of Defense Strategy and Analysis (mainly military logistics)
- Indian Railway Institute of Logistics and Materials Management
- Indian Institute of Logistics in Chennai and Kochi
- Indian Institute of Materials Management in New Delhi
- Indian School of Business Hyderabad
- Indian Institute of Science Bangalore
- Indian Institute of Foreign Trade

- National Institute for Training in Industrial Engineering (NITIE)
- National Institutes of Technologies (NIT)

In the hot-spots of logistics research in India (e.g. Chennai, Mumbai, Ahmedabad, New Delhi, Roorkee, Kolkata and Kharagpur) interviews were carried out with the identified experts. The major areas of research interest at the business and technical-oriented departments were found to be:

- Operations research
- Supply chain management, related to contracts, reverse logistics, automotive logistics, post logistics, health-care operations and pharmaceutical supply chain, aerospace logistics
- Closed loop supply chains
- Heuristics for decision making
- Optimization and planning of inventory and the food supply chain
- Warehousing
- Resource planning
- Communication networks
- Facility layout and location problems (facility planning)
- Risk management in humanitarian supply chains
- Scheduling in the supply chain
- Pricing and revenue management
- Planning and control in manufacturing
- Quality management and service quality
- Operations research applications
- Rural technology
- Supply chain modeling, risks and issues for logistics management and green supply chains
- Computer simulation of the distribution chain

The transport-oriented institutions are specialized in:

- Infrastructure and transportation systems
- Transport policies and logistics sector policies: optimizing the regulation structure, liberalizations as well as barrier analysis
- Designing transportation networks for freight transport modes (rail, water, road, air)
- Optimizing the supply chain and logistics management practices related to infrastructure
- Policy recommendation and consultancy
- Transportation operations and planning
- Railway operations
- Food supply chain management
- Operations research applications in the aviation sector
- Modeling of traffic flow and driver behavior
- Origin-destination models regarding freight
- Solid waste management

### 3.2 Current trends in logistics research

Regarding the topic of globalization, 6 out of 15 institutions work on 8 specific projects in this field. Their specific focus is on outsourcing, global supply chain management, risk management and global issues for logistics and transport modes.

Further, researchers are very active in the field of environment and resource protection. In total 21 projects of 11 institutions are related to this topic. They are working on green logistics and technologies, intermodal transportation systems, urban planning and reducing the carbon impact in the field of transportation and logistics as well as reverse logistics including environmental aspects. Also closed loop supply chains from a waste perspective and the construction and optimization of transportation infrastructure to reduce the carbon foot print are important topics.

When it comes to the topic of innovations in technology there are only 5 institutions active in this field. They develop RFID systems, ICTs and green channeling systems to improve performance in the transportation sector and the supply chains in cities.

Furthermore, 5 institutions currently research in the area of security and risk on 7 projects. They mainly look at risks in supply chains, especially in the food supply chains.

Also, 4 departments concentrate on politics, regulations and compliance with regard to logistic issues. They currently work in the field of public private partnerships in the transportation sector and the standardization of regulations at national level (e.g. toll structure).

The research topic infrastructure development and improvement of material and transport flows is worked on by 4 institutions. They focus on port and railway optimization, improving the hinterland infrastructure, intermodal transport, railway and port connectivity and urban logistics planning regarding last mile distribution as well as logistics nodes. Aside from intermodal transport, they also try to promote water-based transport.

However, most of the research in this sector is carried out by private consultancy firms specific to industry requirements, which makes it inaccessible to the public. At the end, policy level strategies are available, but industry specific research is mostly only possible through consultancy firms.

### 3.3 Existing academic and industry cooperations in logistics research

#### Cooperations between research institutes

Figure 3 shows the distribution of academic research cooperations of the selected institutions. Most of these institutions have active research collaborations with the US, Europe and the UK. They also have about 10 contacts to German institutions. Within India they collaborate with other IITs and IIMs. They are also well connected with Chinese universities. There are some other connections with France, the Netherlands, Canada, Thailand, Taiwan and Saudi Arabia. The activities are mainly focused on exchange programs for students and faculty members with foreign universities (e.g. DAAD). These relationships are very formal. However, outside India, Indian researchers are mainly active in the US and UK. They are working on joint projects in logistics and transportation issues. Often they work together on benchmarking studies. If they have common interest in a specific field, they research together in common projects and work on joint publications.

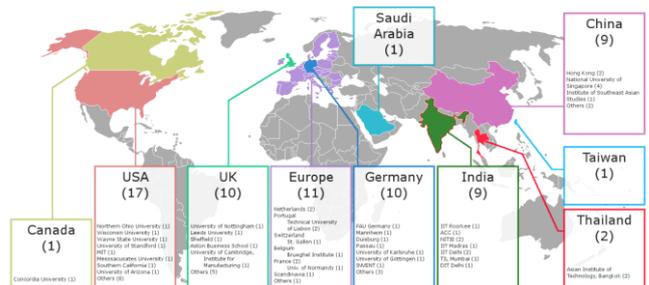


Figure 3: Academic research cooperations

Within India, everyone has his own network of collaborative research in his or her own work domain. All faculties carry out joint research in rather informal groups of researchers that meet at conferences and seminars. IITs for example, have an integrated IIT system where they carry out joint projects with other IITs in certain funded initiatives. They train their students and exchange the capacities to other IITs. The formal way would be to offer exchange programs for researchers and students though. In general, they are connected through some joint programs and some course delivery (e.g. guest lecture) as well some common research agendas, but always depending on personal relationships rather than officially set-up collaborations. Overall, there is not much of a culture for interdisciplinary research within the IIT and IIM system. Only within a few universities, the logistics-oriented researchers work together on several projects with computer scientists (e.g. IIT

Bombay, IIT Delhi). Finally, there are some collaborative research projects in logistics in and with India; the process still is in an early stage though.

**Cooperations between research institutes and industry partners**

In general, most of the institutions have industry connections within India. They are linked with industrial partners of different sectors for which they to optimize processes as well as material and transport flows. To improve the infrastructure for the different transport modes they are well connected with government agencies and work together with them on common projects and initiatives. This way, they are able to provide consultancy services for the private and public sector. In terms of existing logistics business cooperations, joint projects exist with the manufacturing industry, Indian railways, the aviation sector and the government. There are also joint projects with the automotive and food industry. Most of the collaborations are within India though. Fewer activities are with international companies from the US, Europe or other countries. Figure 4 shows the geographic distribution of the institutes’ research cooperations with industry partners.

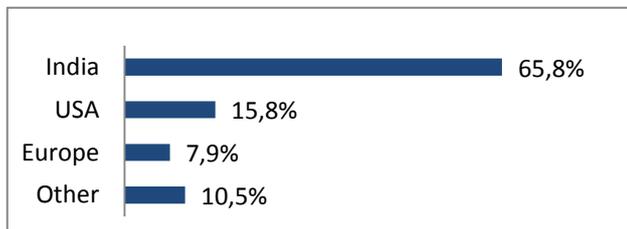


Figure 4: Industry cooperations

**3.4 Logistics networks and clusters in India**

In this chapter we show several logistics networks and clusters in Indian logistics and logistics research. Figure 5 shows 3 logistics hubs in the main metropolitan cities and 9 emerging logistics hubs in the stage of development. There are several logistics hubs in Mumbai, Calcutta, New Delhi and Chennai. Most of common activities in research and industries are in these metropolitan areas. In addition to that, also the major seaports of India, which are important for trade and the logistics industry, are illustrated on the following map.

Every institution has its own network; most of the cooperations are based on personal contacts. Logistics networks and clusters are found in the field of transportation and logistics.

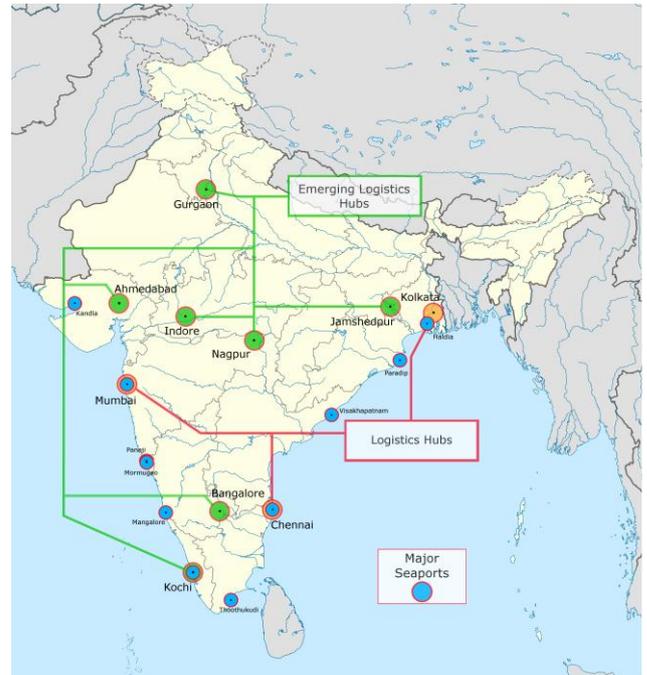


Figure 5: Relevant logistics hubs in India

Academic clusters for logistics and supply chain management consist mainly of the IITs and IIMs as well as NITs (e.g. Bangalore, New Delhi, Calcutta, Lucknow, Ahmedabad, Kharagpur, Madras, Mumbai and Chennai). Concerning transport infrastructure and transportation research, the main clusters are in Ahmedabad, Bangalore, Chennai and Mumbai. IIT Delhi has some very good programs on transport safety and sustainable transport. IIT Madras has specializations in urban transport and the best qualitative research is carried out by the IIMs in Bangalore and Ahmedabad (see Figure 6).

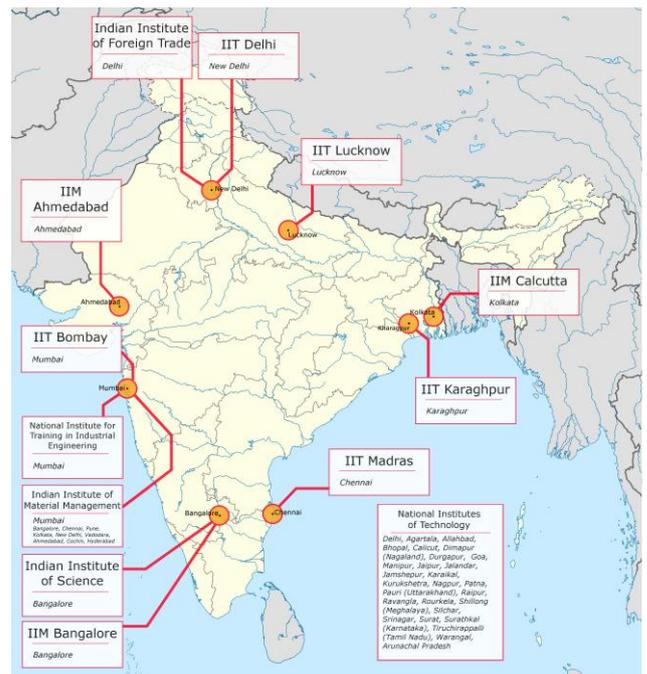


Figure 6: Research clusters in India

A few government agencies on national and state level are active in and work on logistics and transportation issues. 7 national associations were found in India for specific logistics and transportation topics. These associations are common platforms for researchers and the industry to exchange their knowledge in this field. They hold annual conferences, seminars and workshops with the main focus on logistics and transportation where they discuss the current issues and problems in this field (see Table 2).

Logistics networks and clusters	
National government organizations	Ministry of Service Road Transportation and Highways
	National Highways Authority
State government organizations	State roads departments
Associations	Confederation of Indian Industries (CII)
	Loyola, Institute of Business Administration in Chennai (LIBA)
	Federation of Indian Chambers of Commerce and Industry (FICCI)
	Production and Operations Management Association
	Society of Transport Management
International programs	Society of Operations Management
	Supply Chain Operational Research
	Indian Technical and Economic Cooperation (ITEC for international cooperation by the Ministry of External Affairs in disaster relief SC)
	IBSA forum: members from India, Brazil and South Africa

**Table 2: Logistics networks and clusters**

The CII (Confederation of Indian Industry) Institute of Logistics (CIL) in Chennai is a center of excellence in logistics and supply chain management and a common platform for researchers and industry representatives to discuss specific issues and solutions in this field. Further associations related to logistics are the Federation of Indian Chambers of Commerce and Industry, the Production and Operations Management Association, the Society of Transport Management, the Society of Operations Management and the Supply Chain Operational Research. Most of the members in these societies are mostly from the industry. Some of the

researchers are also active in these forums though. They provide conferences and seminars for common knowledge exchange in this field. However, these clusters are very small and there is no national network and no dedicated logistics institution at a country level.

## 4. Current logistics issues and trends in India

### 4.1 Increased outsourcing of logistics services to a developing market

The logistics and supply chain management sector is very informal and fragmented and most of its actors are not very sophisticated. **Informal sector**, in this context, means that they are performing logistics tasks, but almost only with low-tech vehicles and often without warehouses. There are many logistics service providers consisting of only one or two persons owning one or two trucks which are not very organized and whose workload is very volatile. Especially in the big cities, there are a vast number of unorganized small truck owners and service providers for last mile distribution.

Yet, there also are a few larger companies that operate big fleets of well-coordinated vehicles with different capacities. This is rather the exception though and there is no consolidation of that sector within a lobby. There is only the CII or the FICCI. Also, there are no guidelines for traffic tariffs and their payment, which complicates the situation significantly. This especially is a big issue in the **last mile distribution**.

Since many companies in the manufacturing sector are growing in size, non-core activities are being **outsourced**. City level **warehousing** is often given to small players who have their local warehouses, which then outsource warehouse management to other companies. The transport sector is so fragmented that lots of activities are outsourced to smaller players what is even increasing with the manufacturing and retail sector growing in size. Because of SC complexity, time and cost of end-to-end delivery are quite high and companies often have high inventories because their competencies are low. Another issue is that 51 % of the **retail sector** is composed by multinational companies. Despite the growth of the retail sector, integrated **value added services** and **reverse logistics** have not yet been explored for these big supply chains.

However, in the Indian industry there is a high focus on logistics and supply chain management right now. Recently, the **3PL industry** has been growing and holds a high value for multinational companies since warehouse owners will soon be offering a lot of **value added services**. For now, local warehousing companies take care of warehousing and last mile distribution in rather manual and paper-based way. But, as the complexity is increasing, the IT sector is about to pitch in and provide more sophisticated warehousing technologies, especially for the retail sector. Regarding **automation and the use of technology**, high-tech is mostly not affordable for small service providers. Hence, mostly rather lower technologies or even no technology at all is being used in practice. As soon as the sector consolidates further and major players arise, technologies like GPS tracking, ERP solutions or other IT systems will become more common.

In the **trucking sector**, the development of large fleet owners is increasing and many of them are moving into niche markets (e.g. dairy product distribution) and fairly sophisticated services. Large companies are even going further, as for example Tata, which is setting up a company called Tata Infrastructure that includes a large-scale division especially for “Tata-branded” warehousing what can be considered a big step in the **right direction**.

#### 4.2 Safety issues and inefficient regulations

Regarding **risk or safety** in the supply chains, it might not be easy to change the behavior within the informal sector towards more safety. Especially the **human risks** are a major issue in India compared to European countries. Providers mostly overload trucks and have an enormous rate of death since they mostly do not consider investing in security measures due to cost reasons.

Concerning **storage and warehouse related risks**, the fragmented private logistics companies do not cooperate well along the logistic chains, what makes these risks to a big common issue. Only big companies like Tata have their own in-house departments that can manage the risks along the whole supply chain effectively. **Risk management** in global SCs, especially financial risks, are another important issue to be considered in the future.

A further problem area is **regulation**. In certain ways, there is a lack regulations and regulation implementation. Regarding trucks, there is a high tendency to **overloading** and exceeding the driving

time limits. Also, **safety regulations** are very poor what gets even worse when considering road and traffic conditions. The trucks of TATA for example have a capacity of 12 tons, but loads of less than 18 tons are rather exceptions, since people either do not care or simply do not know better. Hence, there is a high rate of accidents at loading facilities and on roads. **Safety laws** do exist, but their **implementation and enforcement** is very problematic. There are some safety-related areas where the laws are even less efficient. In contrast to **crash testing and safety checks** that are mandatory for cars and motorcycles prior to market launch, for trucks and buses this is not the case. Despite the lack of regulation in this area, single vehicle components are produced by many different manufacturers so that crash test results are not valid for the entire vehicle.

Concerning infrastructure, the government dedicates some routes only for trucks. But the major problem is that there is no standardization of the quotes of logistics service providers. The tax structure in India is a further problem. When crossing borders between states, trucks often have to endure long **waiting times** at checkpoints because most states have **different tax structures**. Some states only charge an entry tax, but at most borders all the freight papers need to be checked due to sales tax issues between the states. In addition to that there are also tolls for road usage. The problem related to tolls is that a lot of road improvements are currently happening so that the shift towards electronic tolling is coming very slowly and payments mostly still have to be done manually. However, interstate taxation regulations are still the major issue affecting logistics compared to tolling problems. Finally, the overcoming of these tax obstacles and the standardization of the tax structure in India are a political process that will still take some time.

#### 4.3 Coping with infrastructure deficiencies

India has to expand and improve its infrastructure and further interconnect the existing infrastructure in order to optimize the material and traffic flows, especially for commercial traffic. The loading on seaports and airports is very inefficient, mostly due to issues with the responsible authorities.

**Economic growth** is driving demand in transport and with a losing market share of railways most of the goods are being moved by road. India is considered a manufacturing hub and freight volumes have

drastically increased. Also mining has boomed due to several changes in mining policies so that the movement of minerals within India and abroad has increased dramatically. This issue puts lot of **pressure on the road and rail networks**, especially since illegal mining, which is a big issue in India, is completely handled by road.

The **Indian railways** are still a monopolistic organization with a huge network and an integrated system with 16 zones and 75 divisions, which is not yet ready to be opened up for private ownership. This institution is a department of the government and a huge entity with approximately around 100,000 employees. However, it is only one single inflexible company that has difficulties to associate with outside partners. Even though there are initiatives for improvement, they all need to be approved through a very long and inefficient internal process. The railway infrastructure is still on a stage of “not yet broken down”, other sectors are doing better though. There is work being done in the areas of development of locomotives, manufacturing of coaches, catering on trains, constructing lines, operating services, pricing and scheduling. However, rail construction and signaling equipment installations are still done by companies like Siemens. All in all, there is a huge potential and interest in railways.

The use of **inland waterways**, primary in the east, connecting Calcutta and the ports in Orissa to the mines, has been explored, but inland waterways have been a huge failure since the water levels are too low and fresh water is rather used for consumption and agriculture than for transportation. Further, the inland waterway network is not maintained at all so that there is a complex set of problems in that area.

Today, **warehousing** and **rail-road interfacing** are major issues concerning sustainability and transport costs. Bulk is being moved by rail since railway lines can be connected directly to mines or big manufacturing plants. For consumer goods and durables on the other hand, there is a significant flow between Mumbai and Delhi or Ahmadabad that still needs to be done by truck because the interfacing is still not good enough.

Regarding the **promotion of intermodal transport** policy makers decide and researchers depend on these decisions. An intermodal approach is not yet planned in India so that there is not much significant work being done to improve logistics nodes and promote intermodal transport.

The development in the transportation sector is huge though. It is growing about 10% per year, but only in scale. A lot of freight was done by rail in the past, but now truck transportation is increasing, because the roads have been improved. Also, the truck sector is growing faster than the railway sector and private seaports are coming up. The greatest potentials are in the **intermodal logistics nodes for transport networking and transport distribution** since there also is some political interest in this area. In fact, Mumbai or Chennai are candidates for being an intermodal hub, because there is a high rate of traffic, industrial activities and a sea port. Yet, an intermodal approach for these hubs is not yet being developed.

The **improvement of logistics nodes** is a key issue and requires an integrated local initiative of the different players in that sector. But these players only might come together if they see some a common financial motivation in their cooperation since all the different types of **necessary investments** need to be made by different actors. But right now there are too many independent players that are not working together. These **intermodal issues** primarily arise because the industry is the main user of the public roads, but does not have any incentive or even permission to invest in these roads. The government is rather interested in the main backbone than in the hinterland distribution since the traffic flows are probably not big enough to justify large investments.

In this context, **PPPs** (Public Private Partnerships) are a key issue. The objective is to involve the private sector in road infrastructure improvements since commercial traffic would get facilitated this way. PPPs are an issue that has a lot of potential on both, academic and government level so that there are a lot of options for collaborations. Finally, there are many schemes related to infrastructure where the government is looking for academic input.

Regarding urban distribution on the **last mile**, it is very difficult to serve single parcels to customers since in most Indian cities the infrastructure is not developed enough for parcel services and the urban areas are not very familiar with this kind of logistics. **Urban freight logistics** is a big area of concern where not enough is being done. In cities like Ahmadabad or Delhi, during the day, trucks are not allowed on the main roads. One problem is that trucks come in the night and create massive traffic congestions since they all start moving at the same time (in Delhi for example). The other problem is that there are additional handling issues for larger trucks

since they are not allowed inside the city. In this context, warehouses around the city need to be booked in order to move the goods to small vehicles for retail distribution. As a result, urban last mile distribution is a huge issue in India.

However, the **infrastructure corridor** Delhi-Mumbai and the related freight corridors for rail are currently being developed. Also between Delhi, Jawaharlal Nehru Port and Calcutta **dedicated rail freight corridors** are being developed. The involved parties are also planning to build a high number of logistics clusters and container freight stations (CFS) along these corridors. Regarding multimodal logistics hubs, primarily between road and rail, optimal locations still need to be identified. Also the **connectivity from the mines** (minerals) to the Delhi-Mumbai Industrial Corridor is being improved. Furthermore, other container freight stations are currently being planned. This includes hubs in the Delhi region, at Chennai international airport on the east coast, at the National Capital Region in north central, at Jawaharlal Nehru Port on the west coast and in Chennai on the east coast. Also an aviation hub in Nagpur (center of India) is being planned.

Substantial improvements are necessary since logistics can only be managed effectively when the infrastructure is good. There is a focus on **national highway development** that includes expressways, super expressways and air linkages. Also the **aviation sector** has grown tremendously, but infrastructure related to civil aviation still needs to be developed much further. Nashik, Gurgaon and Kochi are **new logistics clusters or hubs**. A major dry port near Delhi is a hub for distributing within the country.

#### 4.4 Major issues in cold and food chains

There are many activities in the area of cold and food chain management due increased government initiative and funding in this area. India has an old but quite good public distribution system for movements of food across the country. The major food crops are in localized pockets near to Delhi and are distributed all over the country from there. The crops need to be delivered to warehouses in order to be processed though. Warehousing in food supply chains is a very big problem in this case. Agricultural SCM is rather unorganized and inefficient and the public distribution system in food SCs is not very effective either. There is a lot of wastage during storage, lead times are high and security issues are not considered. The aim would be to develop good warehouses, cold chains

and food chains. So finally, the agricultural, processed food and cold chains need to be improved significantly. Therefore, the government is currently making substantial investments in this area, mainly in the food chains though.

#### 4.5 Lack of specialized training and education

Even though the logistics sector is growing, whether it is roads, aviation, railways, containers or the use of various modes of transport, the amount of students and the technical knowledge in the sector is quite low. But in the manufacturing part of the curriculum, people have an understanding of different technologies so that they can find a natural way to enter those sectors. In the areas of logistics there is a great need for education, but there are not enough institutions that offer training in logistics. Compared to engineering and manufacturing, where students intensively learn the topic and finally can get their qualification certified, in the area of logistics and transport, this is only very rare, since there is a lack of specialized educational training institutes in this sector. However, the skill development efforts in the transportation, warehousing and packaging sector are an important trend. Not only skills, but also attitude and behavior are important in managing supply chains and need to be dramatically improved. The academic institutions do not cooperate well with other institutions so that knowledge is not being shared and developed efficiently.

### 5. Summary of study results and outlook

Taking the overview of the scientific activities in the field of logistics in India as a starting point, the current situation and especially the current 'state of the art situation' were presented and current research projects, networks, clusters and trends in this field were identified to provide starting points for research cooperations. The target is to establish and intensify cooperation with the clusters of logistics and logistics research in India, in order to develop innovative and sustainable concepts with Indian and German companies as well as research institutions. In the medium term an Indo-German platform could be established by the government with the Indian and German researchers to support an effective communication and information, research and education transfer.

The first task was to contact potential research partners and to get a feeling of the meaning of

logistics research in India. It was important for the German research team to understand the structures of the Indian institutes, their research focus and the way in which they carry out research. The next step would be to develop new common approaches for research. In this context, German and Indian researchers should discuss the next steps for working together at a round table discussion. However, it will be a challenge to develop a common exchange platform, as the systems of Germany and India are very different and both parties need to understand the backgrounds of these systems.

India is a very rapidly developing country, especially when it comes to its infrastructure. For cooperations, the needs of both countries should be identified in order to find concrete and efficient solutions to reach a win-win-situation for both sides. The German side could transfer its experiences in efficient infrastructure planning for freight transportation, especially since logistics nodes and the infrastructure between them are central points of interest for the Indian government and industry.

This project was promoted in order to create an overview of what is really going on in India when it comes to research in logistics. Finally, there is still a lot of potential in this field, so that especially the German side, supported by the government, should find ways for cooperation and networking with Indian research groups and try to initiate cooperations.

In summary, this report has revealed that although some common collaboration already exist between German and Indian logistics institutions, there is considerable scope and willingness on both sides for improving this situation.

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